DESIGN OF THE STEEL SKELETON FOR AN OFFICE BUILDING

BY
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ARMOUR INSTITUTE OF TECHNOLOGY

1912

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Design of the steel skeleton
for an office building

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THESIS

THE DESIGN OF THE STEEL SKELETON
FOR AN
OFFICE BUILDING

Presented By

Chas. W. Collins
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to the

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INDEX.

Art.	Subject.	Page.
1.	Introduction	1.
2.	Discussion	1 - 3
3.	Plate I-Design of Floor and Stringer	4
4.	Table 1-R and 1a R	5 - 6
5.	Plate II-Design of Roof Beam and Girder	7
6.	Table 2-R to 6-R	8-12
7.	Plate III-Design of Floor Beam	13
8.	Table 1F to 3F	14-17
9.	Plate IV- Design of Floor Girder	18
10.	Table 4F to 7F	19-22
11.	Plate V and Va-Design of Exterior Columns	23-24
12.	Table - Tc	25
13.	Plate VI-Design of Interior Columns	26
14.	Table Zc	27
15.	Plate VII-Design of Column Base	28
16.	Table 1B - 1aB	29-30
17.	Plate VIII-Framing Plans	31
18.	Plate IX - Typical Details	32

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THE DESIGN OF THE STEEL SKELETON FOR AN OFFICE BUILDING.

The concentration of commercial interests within limited areas in large cities has been found to be advantageous both as to time and convenience,and has caused the introduction and adoption of the steel skeleton or cage building. To Mr. W. L. B. Jenney, a prominent Chicago architect and architect for the Home Insurance Building in 1883, belongs the credit for the conception of skeleton construction. By a bold and progressive departure from previous practice, he introduced methods of construction which were soon generally adopted.

After the plans of a building have been compiled by an architect, it is an engineer's problem to design the steel work. The latter is what has been done in this thesis. A building of indefinite height could have been designed, but it was thought a ten-story building would involve the same problems as a twenty-story one, i.e., as it was only a question of time, it was determined to limit the height to ten stories.

The northwest corner of Monroe and Clark Streets, Chicago, was selected as a desirable site for the building under consideration. To space columns correctly and for the layout of offices, corridors, stairways, and elevators, an architect's plan for a building is necessary, but it was almost impossible to obtain a plan. Finally a small text-book plan of the New York Life Insurance Building, located at the northeast corner of LaSalle and Monroe Streets, Chicago, was obtained. After changing a few minor dimensions, it was possible to adjust the plan to the site selected.

The lot is 80'-0" x 140'-0", and the light court in the rear of the building is 27'-6" x 55'-1 3/8". The height of the main floor is 15'-0", while the remaining floors, including the basement, are 12'-0" high, thus making the total height 135'-0". The ceiling of the tenth floor is suspended by hangers from the roof, which at its lowest point is about three feet above the ceiling.

As specifications, the December, 1911 issue of the "Revised Building Ordinances of the City of

Chicago" was followed throughout. Freitag's "Architectural Engineering," Kidder's "Architect's Handbook," and the Handbooks of the Cambria and Carnegie Steel Companies were found to be of valuable assistance in the design. Much information was also obtained from the drawings furnished by R. C. and E. C. Shankland and Ritter and Mott, both prominent Chicago engineering firms.

The design naturally divided itself into

(1) Roof design (including joists or stringers, beams, and girders).

(2) Floor design.

(3) Column design (Exterior and Interior).

(4) Column bases and foundation design.

Typical Design of Floor and Stringer

Span = 15'6 $\frac{11}{16}$"   Effective width = 7'9 $\frac{11}{32}$"

Will use End Construction Arch on floor

Depth = 12"   Weight = 39# per sq. ft.

Safe load for a 12" arch 7'9 $\frac{11}{32}$" span = 200#/sq. ft.

Live load — — — — — — — — = 75# per sq. ft.

Weight of Plaster Ceiling — — — — . = 10# " "

" " Floor — — — — — = 5# " "

" " Arch — — — — — = 39#

Total load = 129#

Effective Depth of a 12" arch = 9.6"

$\frac{3}{4}$" tie rods spaced 3.1'   (Cambria - 63)

$T = 3Pl/R$ where T = thrust of arch, P = total unit load, l = span and R = effective depth.

$$T = \frac{3 \times 129 \times \overline{7.78}^2}{2 \times 9.6} = 1220\#.$$

$p' = \frac{wbB^2}{2I}$ where p = stress due to lateral forces, w = thrust, B = distance between tie rods, b = width of flange, and I = moment of inertia of the assumed section normal to the line of application.

Assume a 9" 21# I beam.

$$p' = \frac{1220 \times 3.1^2 \times 4.33}{2 \times 5.16} = 4900\#$$

$$p = 16000\# - 4900\# = 11,100\#$$

$\frac{11100}{16000} = 69.5\%$ % of maximum load which can be carried as a vertical load.

Safe load = 12580# − 16 × 21# = 12,244#   (Cambria 87)

12,244 × 69.5 = 8500#

Load to be carried = $129 \times 16 \times \frac{7.78}{2}$ = 8000#

ROOF STRINGERS

Mark	Uniform Loading		Section	Weight	Length C to C
	Live	Dead			
1-11	9300	6700	10"-25# I	400	16'-0"
2-10	9600	6900	10"-30# I	495	16'-6"
3-9	11620	8380	12"-35# I	700	20'-0"
4-8	8000	5800	9"-21# I	290	13'-9"
5-7	"	"	" " "	"	"
8-18	"	"	" " "	"	"
9-17	"	"	" " "	"	"
10-16	11620	8380	12"-35# I	700	20'-0"
11-15	9600	6900	10"-30# I	495	16'-6"
12-14	9300	6700	10"-25# I	400	16'-0"
13-23	"	6700	" " "	400	"
14-22	9600	6900	10"-25# I	495	16'-6"
15-21	11620	8380	12"-35# I	700	20'-0"
22-28	"	"	" " "	700	"
23-27	9600	6900	10"-30# I	495	16'-6"
24-26	9300	6700	10"-25# I	400	16'-0"
25-35	"	"	" " "	"	"
26-34a	9600	6900	10"-30# I	495	16'-6"
26-34c	10000	7250	" " "	"	"
27-33a	11620	8380	12"-35# I	700	20'-0"
27-33c	12150	8750	" " "	"	"
32-44a	9300	6700	10"-25# I	400	16'-0"
32-44b	8950	6450	" " "	"	"
33-43a	6700	4820	9"-21# I	242	11'-6"
33-43b	6430	4630	" " "	"	"
34-42b	12400	8900	15"-42# I	930	22'-2 11/32"
34-42a	14300	10300	" " "	1030	24'-6 29/32"
35-41c	9650	6950	10"-30# I	495	16'-6"

TABLE 1a-R

ROOF STRINGERS CONT'D.

Mark	Uniform Loading		Section	Weight	Length C to C
	Live	Dead			
35-41a	6950	5000	10"-25# I	300	11'-11 3/32"
35-41b	7960	5740	" " "	360	14'-3 21/32"
36-38	9300	6700	" " "	400	16'-0"
37-40	9300	"	" " "	"	"
39-49	9300	"	" " "	"	"
40-48	6700	4820	9"-21# I	242	11'-6"
41-47	14600	10400	15"-60# I	1500	25'-0"
42-46	6700	4820	9"-21# I	242	11'-6"
43-45	9300	6700	10"-25# I	400	16'-0"
46-56	"	"	" " "	400	16'-0"
47-55	6700	4820	9"-21# I	242	11'-6"
48-54	14600	10400	18"-55# I	1375	25'-0"
49-53	6700	4820	9"-21# I	242	11'-6"
50-52	9300	6700	10"-25# I	400	16'-0"

Typical Design of a Roof Beam and Girder

Exterior Beam 1-2

Liveload = 75# per sq. ft.   Span = 16'0".
Dead load = 54# " " "

Total live load = 75X16X3.89 — — — — = 4650#
" dead " = 54X16X3.89 — — — — = 3350#
Total uniform load = 8000#

Use a 9"21# I beam, maximum allowed load = 12580# for a span of 16'0". This size beam taken as minimum sized beam to be used (Cambria 87)

Interior Beam 12-11

Unit load same as for 1-2   Span = 16'0".

Total live load = 75X16X7.78 — — — — = 9300#
" dead " = 54X16X7.78 — — — = 6700#
Total uniform load — — = 16000#

Use a 10"25# I beam, maximum allowed load = 17360# (Cambria 87)

Exterior Girder 1-12

Span = 15'6$\frac{1}{16}$"

Concentrated load from stringer 1-11 is $\frac{9300}{2}$ = 4650# live load and $\frac{6700}{2}$ = 3350# dead load. Total load = 8000#

Since the tables are made for a uniform load, a concentrated load at the centre must be multiplied by 2 to get the equivalent uniform load.

8000# X 2 = 16000# equivalent uniform load

Use a 10"25# I beam, maximum allowed load = 16280# for a 16'0" span. (Cambria-87)

Interior Girder 2-11

Concentrated load from stringers 1-11 and 2-10 = $\frac{9300+9600}{2}$ = 9450# live load, and $\frac{6700+6900}{2}$ = 6800# dead load. Total concentrated load = 16250#

See (1-12). 16250X2 = 32500#. Use 15"42# I. allowed load = 39270# - 16'0"

TABLE 2-R

EXTERIOR ROOF BEAMS

Mark	Uniform Loading		Section	Weight	Length C. to C.
	Live	Dead			
1-2	4650	3350	9"-21# I	336	16'-0"
51-52	″	″	″ ″ ″	″	″ ″
55-56	″	″	″ ″ ″	″	″ ″
2-3	4800	3450	″ ″ ″	347	16'-6"
3-4	5810	4190	10"-31.5# I	630	20'-0"
4-5	4000	2900	9"-21# I	290	13'-9"
5-6	″	″	″ ″ ″	″	″ ″
17-18	″	″	″ ″ ″	″	″ ″
16-17	″	″	″ ″ ″	″	″ ″
31-32	4520	3280	″ ″ ″	336	16'-6"
32-33	3250	2350	″ ″ ″	242	11'-6"
52-53	3350	2410	″ ″ ″	″	″ ″
54-55	″	″	″ ″ ″	″	″ ″
53-54	7300	5200	15"-42# I	1050	25'-0"

TABLE 3-R

INTERIOR ROOF BEAMS

Mark	Loading		Section	Weight	Length c to c.
	Live	Dead			
11-12	9300	6700	10" 25# I	400	16' 0"
10-11	9600	6900	10" 30# I	495	16' 6"
9-10	11620	8380	12" 35# I	700	20' 0"
8-9	8000	5800	9" 21# I	290	13' 9"
7-8	8000	5800	" " "	"	" "
15-16	11620	8380	12" 35# I	700	20' 0"
14-15	9600	6900	10" 30# I	495	16' 6"
13-14	9300	6700	10" 25# I	400	16' 0"
23-24	9300	6700	" " "	"	" "
22-23	9600	6900	10" 30# I	495	16' 6"
21-22	11620	8380	12" 35# I	700	20' 0"
28-27	11620	8380	" " "	"	" "
26-27	9600	6900	10" 30# I	495	16' 6"
25-26	9300	6700	10" 25# I	400	16' 0"
36-35	9300	6700	" " "	"	" "
34-33	11620	8380	12" 35# I	700	20' 0"
38-37	9300	6700	10" 25# I	400	16' 0"
39-40	9300	6700	" " "	"	" "
40-41	6700	4820	9" 21# I	242	11' 6"
41-42	14600	10400	15" 60# I	1500	25' 0"
42-43	6700	4820	9" 21# I	242	11' 6"
43-44	9300	6700	10" 25# I	400	16' 0"
45-46	9300	6700	" " "	"	" "
46-47	6700	4820	9" 21# I	242	11' 6"
48-49	6700	4820	9" 21# I	242	11' 6"
47-48	14600	10400	15" 60# I	1500	25' 0"
50-49	9300	6700	10" 25# I	400	16' 0"

EXTERIOR ROOF GIRDERS

Mark	Concentrated Load		Section	Weight	Length C. to C.
	Live	Dead			
6-7	4000	2900	10"-25#I	390	15'-6 11/16"
7-8	4000	2900	10"-25#I	390	"
16-21	5810	4190	12"-31.5#I	490	"
21-28	5810	4190	" " "	"	"
28-33	11890	8570	15"-45#I	1080	24'-0"
31-44	9125	6575	" " "	950	22'-8 1/16"
44-45	4650	3350	10"-25#I	390	15'-6 11/16"
45-56	"	"	" " "	"	15'-6 11/16"
51-50	"	"	" " "	"	"
50-39	"	"	" " "	"	"
39-37	"	"	" " "	"	"
37-36	"	"	" " "	"	"
36-25	"	"	" " "	"	"
25-24	"	"	" " "	"	"
24-13	"	"	" " "	"	"
13-12	"	"	" " "	"	"
12-1	"	"	" " "	"	"

INTERIOR ROOF GIRDERS

Mark	Concentrated Load		Section	Weight	Length C to C
	Live	Dead			
2-11	9450	6800	15"-42# I	650	15'-6 11/16"
3-10	10600	7640	" " "	"	"
4-9	9810	7090	" " "	"	"
5-8	8000	5800	12"-40# I	620	"
8-17	"	"	" " "	"	"
9-16	9810	7090	15"-42# I	650	"
11-14	9450	6800	15"-42# I	650	15-6 11/16"
14-23	"	"	" " "	"	"
15-22	10000	7640	" " "	"	"
22-27	"	"	" " "	"	"
23-26	9450	6800	15"-42# I	650	"
26-35	"	"	" " "	"	"
27-34	21690	15640	20"-65# I	1560	24'-0"
32-43	15390	11200	18"-55# I	1250	22'-8 1/16"
33-42	21325	15685	20"-65# I	1480	"
34-41	21300	15420	" " "	1530	23'-6 5/8"
35-38	9475	6825	15"-42# I	650	15'-6 11/16"
38-40	8625	5850	" " "	"	"
40-49	8000	5760	12"-40# I	620	"
41-48	10650	7610	15"-42# I	650	"
42-47	"	"	" " "	"	"
43-46	8000	5760	12"-40# I	620	15'-6 11/16"
46-55	"	"	" " "	"	"
47-54	10650	7610	15"-42# I	650	"
48-53	"	"	" " "	"	"
49-52	8000	5760	12"-40# I	620	"
10-15	10600	7640	15"-42# I	650	"

COURT
ROOF STRINGERS-BEAMS and GIRDERS

Mark	Loading		Section	Weight	Length c to c
	Live	Dead			
29-31	4630	5370	10" 25# I	400	16'-0"
17-19	"	"	" " "	312	14'-10½"
28-32-c	6700	4820	9" 21# I	236	11' 6"
28-32d	"	"	" " "	"	" "
21-29	"	"	" " "	"	" "
16-20	"	"	" " "	"	" "
17-18	9270	15340	12" 40# I	640	16' 0"
32-37	"	"	" " "	"	" "
33-32	6700	11700	10" 25# I	290	11' 6"
28-29	"	4820	9" 21# I	236	" "
20-21	"	"	" " "	"	" "
17-16	"	11700	10" 25# I	290	" "
30-31	conc 2315	4180 conc. 2685	12" 31.5# I	756	24' 0"
19-30	—	4180	9" 21# I	326	15' 6 1/16"
18-19	conc 2315	2090 conc. 2685	" " "	"	" "
17-20	conc. 5680	2090 conc. 3100	12" 35# I	545	" "
20-29	conc. 3350	4180 conc. 2410	10" 30# I	466	" "
29-32	conc. 9015	4180 conc. 7800	18" 55 I	1320	24' 0"
28-33	conc. 6700	14400 conc. 4820	" " "	"	" "
21-28	conc. 3100	9330 conc. 2410	12" 31.5# I	490	15' 6 1/16"
16-21	conc. 5800	9330 conc. 6225	18" 55# I	855	" "

Assumed in the design that load from skylight = 40# per foot of horizontal surface.

Typical Design of a Floor Beam

Exterior Beam 1-2 — Span = 16'0".

Live load = 75# per sq. ft.
Dead " = 54# " " "

In addition there is a 12" brick wall on the beam. An assumption was made that 5' of wall is resting on the beam. Brick weighs 120# per cu. ft.

Total live load = 75 X 3.89 X 16 — — = 4650#
Dead load = 54 X 3.89 X 16 — — = 3350#
Weight of brick wall = 120 X 16 X 5 — — = 9600#
Total dead load — — — — - = 12950#
" uniform " — — — — — = 17600#

Use a 12"-35# I beam allowed uniform load = 23,980# for 16'0" span (Cambria 88)

Interior Beam 12-11.

Unit load same as above but instead of brick wall there is a 6" partition on the beam. Weight of 6" partition = 43# per sq. ft. of wall.

Live load = 75 X 7.78 X 16 — — — = 9300#
Dead " = 54 X 7.78 X 16 — — — = 6700#
Weight of Partition = 43 X 16 X 12 — — = 8300#
Total dead load — — — — = 15000#
" uniform " — — — — = 24300#

Use a 12"35# I beam allowed uniform load = 25,360# for a 16'0" span. (Cambria 88)

TABLE 1-F

FLOOR STRINGERS

Mark	Uniform Loading		Section	Weight	Length C. to C.
	Live	Dead			
1-11	9300	15000	12"-35# I	560	16'-0"
2-10	9600	10250	12"-31.5# I	520	16'-6"
3-9	11620	12280	15"-42# I	840	20'-0"
4-8	8000	9350	10"-25# I	344	13'-9"
5-7	8000	5800	9"-21# I	290	13'-9"
8-18	"	"	" " "	"	"
9-17	"	"	" " "	"	"
16-10	7000	5100	" " "	252	12'-0"
11-15	9600	6900	10"-30# I	495	16'-6"
12-14	9300	15000	12"-35# I	560	16'-0"
13-23	"	"	" " "	"	"
14-22	9600	6900	10"-30# I	495	16'-6"
15-21	11620	4050 8380	15"-42# I	840	20'-0"
22-28	7000	5100	9"-21# I	252	12'-0"
23-27	9600	6900	10"-30# I	495	16'-6"
24-26	9300	15000	12"-35# I	560	16'-0"
25-35	"	"	" " "	"	"
26-34d	9600	6900	10"-30# I	495	16'-6"
26-34c	10000	15800	12"-40# I	660	16'-6"
27-33d	7000	5100	9"-21# I	252	12'-0"
27-33c	7290	5250	" " "	"	"
32-44a	9300	6700	10"-25# I	400	16'-0"
32-44b	8900	6450	" " "	"	"
33-43a	6700	4820	9"-21# I	242	11'-6"
33-43b	6430	4630	" " "	"	"
34-42b	12400	4050 8900	15"-60# I	1330	22'-2 11/32"
34-42a	14300	4050 10300	" " "	1470	24'-6 29/32"
35-41e	9650	6950	10"-30# I	495	16'-6"

TABLE 1a-F

FLOOR STRINGERS CONTINUED

Mark	Uniform Loading		Section	Weight	Length C. to C.
	Live	Dead			
35-41a	6950	5000	10"-25# I	300	11'-11 3/32"
35-41b	7960	13090	12"-31.5# I	450	14'-3 21/32"
36-38	9300	15000	12"-35# I	560	16'-0"
37-40	"	"	" " "	"	" "
39-49	"	6700	10"-25# I	400	" "
40-48	6700	6520 Con. 4050	" " "	290	11'-6"
41-47	4600	23250 Con. 2025	15"-70# I	1750	25'-0"
42-46	6700	10770	10"-25# I	290	11'-6"
43-45	9300	15000	12"-35# I	560	16'-0"
46-56	"	6700	10"-25# I	400	" "
47-55	6700	4820	9"-21# I	242	11'-6"
48-54	14600	10300 Conc 4050	18"-55# I	1375	25'-0"
49-53	6700	4820 Conc 4050	10"-25# I	290	11'-6"
50-52	9300	6700	" " "	400	16'-0"

TABLE 2-F

EXTERIOR FLOOR BEAMS

Mark	Uniform Loading		Section	Weight	Length C to C
	Live	Dead			
1-2	4650	12950	12"-31.5# I	504	16'-0"
51-52	"	"	" " "	"	" "
55-56	"	"	" " "	"	" "
2-3	4800	16050 Conc. 2580	15"-42# I	690	16'-6"
3-4	5810	19410 Conc. 2580	" " "	840	20'-0"
4-5	4000	11150	10"-25# I	344	13'-9"
5-6	"	"	" " "	"	" "
17-18	"	"	" " "	"	" "
16-17	"	"	" " "	"	" "
31-32	4520	12880	12"-31.5# I	504	16'-0"
33-32	3250	9250	9"-21# I	242	11'-6"
52-53	3350	9310 2025	" " "	"	" "
54-55	-	9310	" " "	"	" "
53-54	7300	20200 Con. 2025	18"-55# I	1375	25'-0"

TABLE 3-F

INTERIOR FLOOR BEAMS

Mark	Loading		Section	Weight	Length C to C.
	Live	Dead			
11-12	9300	15000	12" 35# I	560	16'-0"
10-11	9600	15800	15" 42# I	680	16'-6"
9-10	3000 7000	2050 5050	" " "	840	20'-0"
8-9	8000	9300	10" 25# I	344	13'-9"
7-8	8000	12900	12" 31.5# I	435	13'-9"
15-16	3300 11680	4075 13330	18" 55# I	1100	20'-0"
14-15	9600	15800	15" 42# I	680	16'-6"
13-14	9300	15000	12" 35# I	560	16'-0"
23-24	"	"	" " "	"	" "
22-23	9600	15800	15" 42# I	680	16'-6"
21-22	9300 Con. 1750	8000 Con. 3520	" " "	840	20'-0"
28-27	7000 Con. 5320	5050 Con. 3860	" " "	840	20'-0"
26-27	9600	15800	" " "	680	16'-6"
25-26	9300	15000	12" 35# I	560	16'-0"
36-35	"	"	" " "	"	" "
34-33	9300 Con 3575	10850 Con 4560	18" 55# I	1100	20'-0"
38-37	9300	15000	12" 35# I	560	16'-0"
39-40	"	"	" " "	"	" "
40-41	6700	10770 Con 2025	10" 30# I	345	11'-6"
41-42	14600	17100 Con 2025	18" 55# I	1375	25'-0"
42-43	6700	10720	10" 25# I	290	11'-6"
43-44	9300	15000	12" 35# I	560	16'-0"
45-46	"	6700	10" 25# I	400	" "
46-47	6700	4820	9" 21# I	242	11'-6"
47-48	14600	10400 Con 4050	18" 55# I	1375	25'-0"
48-49	6700	9070 Con 4050	10" 30# I	345	11'-6"
49-50	9300	15000	12" 35# I	560	16'-0"

Typical Design of a Floor Girder

Exterior Girder 1-12 Span=15'6 11/16"

Load is concentrated at the centre due to stringer 1-11, and a uniform load due to the brick wall.

Concentrated load $\frac{9300}{2}$ = 4650# live load
$\frac{15000}{2}$ = 7500# dead load
Total concentrated load= 12150#

Uniform load = 15.63 X 12 X 120 — — — = 9420#
Equivalent uniform load due to stringer= 2X 12150#= 24300#
Total " " " = 24300#+ 9420#= 33720#
Use a 15" 42# I beam, maximum allowed load= 39270# for a 16'0" span. Cambria 89

Interior Girder 2-11 Span=15'6 11/16"

Load is concentrated at the centre due to stringers 1-11 and 2-10.

Concentrated load:-
Live load = $\frac{9300+9600}{2}$ = — — — — 9450#
Dead " = $\frac{15000+11050}{2}$ = — — — — 12625#
Total load = — — — — 22050#

Equivalent uniform load= 22050X2 = 44100#
Use an 18" 55# I beam, maximum allowed load = 58930# for a 16'0" span (Cambria 92)

TABLE 4-F

EXTERIOR FLOOR GIRDERS

Mark	Conc Loading		Uniform D.L.	Section	Weight	Length C. to C.
	Live	Dead				
6-7	4000	2900	9420	12"-35# I	550	15'-6 11/16"
7-18	"	"	"	" " "	"	" "
16-21	5810	10400	"	15"-50# I	785	" "
21-28	0	0	"	9"-21# I	330	" "
28-33	0	0	14400	12"-31.5# I	760	24'-0"
31-44	9125	6575	13600	20"-70# I	1600	22'-8 1/16"
44-45	4650	7500	9420	15"-42# I	650	15'-6 11/16"
45-56	"	3350	"	12"-40# I	630	" "
51-50	"	"	"	" " "	"	" "
50-39	"	"	"	" " "	"	" "
39-37	"	7500	"	15"-42# I	650	" "
37-36	4650	"	9420	" " "	"	15'-6 11/16
36-25	"	"	"	" " "	"	" "
25-24	"	"	"	" " "	"	" "
24-13	"	"	"	" " "	"	" "
13-12	"	"	"	" " "	"	" "
12-1	"	"	"	" " "	"	" "

TABLE 5-F

INTERIOR FLOOR GIRDERS

Mark	Conc. Loading		Uniform D.L.	Section	Weight	Length C. to C.
	Live	Dead				
2-11	9450	12625	0	18"-55# I	860	15'-6 11/16"
3-10	10600	11315	8100	" " "	"	" "
4-9	3100 9810	1550 10820	0	" " "	"	" "
5-8	8000	5800	8100	15"-42# I	660	" "
8-17	"	"	"	" " "	"	" "
9-16	3100 4000	1550 2700	"	" " "	"	" "
10-15	8300	6000	"	" " "	"	15'-6 11/16"
11-14	9450	10950	"	18"-55# I	860	" "
14-23	"	"	8100	" " "	"	" "
15-22	9610	9540	"	" " "	"	" "
22-27	8300	6000	"	15"-42# I	660	" "
23-26	9450	10950	"	18"-55# I	860	" "
26-35	"	10950	"	" " "	"	" "
27-34	8300 8645	6000 10530	12400	2-20"-70# I	3360	24'-0"
32-43	9000 7690	5760 5540	11700	24"-95# I	2160	22'-8 11/16"
33-42	10500 9415	9590 8790	0	2-20"-65# I	2950	" "
34-41	10625 10180	9675 13020	11700	2-24"-80# I	3760	23'-6 5/8"
35-38	9475	10975	8100	18"-55# I	860	15'-6 11/16"
38-40	8125	10000	"	" " "	"	" "
40-49	8000	8625	0	15"-42# I	660	" "
41-48	10650	17925	0	18"-55# I	860	" "
42-47	"	"	4050	18"-60# I	940	" "
43-46	8000	12890	"	18"-55# I	860	" "
46-55	"	5760	8100	15"-42# I	660	15'-6 11/16"
47-54	10650	9590	"	18"-55# I	860	" "
48-53	"	11610	0	" " "	"	" "
49-52	8000	7785	0	15"-42# I	660	" "
10-16	3100 3500	1550 2550	0	12"-31.5# I	490	" "
22-28	3500	2550	0	10"-25# I	390	" "
27-33	3500 3645	2550 2625	0	15"-42# I	1000	24'-0"

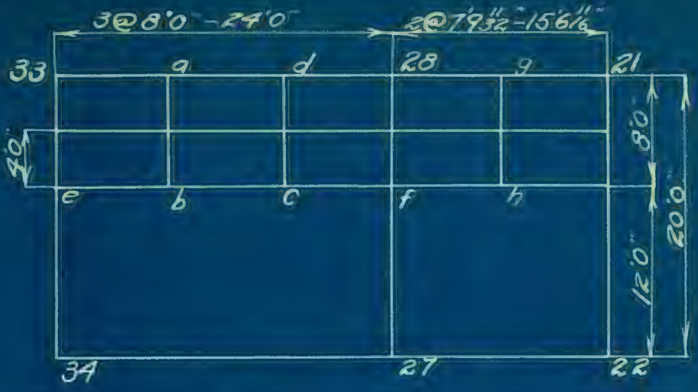
COURT
FLOOR STRINGERS, BEAMS and GIRDERS

Mark	Loading		Section	Weight	Length c to c
	Live	Dead			
17-19	23200	6750	15" 42# I	675	14' 10½"
20-30	24900	6750	" " "	672	16' 0"
29-31d	"	"	" " "	"	" "
29-31c	"	"	" " "	"	" "
16-20	23200	6750	" " "	675	14' 10½"
21-29	17900	4830	10" 30# I	345	11' 6"
28-32-c	"	"	" " "	"	" "
28-32-d	"	"	" " "	"	" "
20-19	24900	6750	15" 42# I	672	16' 0"
29-30	"	"	" " "	"	" "
17-18	14700	16770	" " "	578	13' 9"
16-17	"	"	" " "	"	" "
31-32	17100	19450	" " "	672	16' 0"
32-33	9150	17150	12" 31.5# I	362	11' 6"
21-20	17900	4830	10" 30# I	345	" "
28-29	"	"	" " "	"	" "
32-33	12300	14000	12" 31.5# I	362	" "
18-19	conc 11600	9330 conc. 3175	12" 31.5# I	490	15' 6 11/16"
19-30	conc. 12450	9330 conc. 3175	" " "	"	" "
30-31	conc. 24900	14400 conc. 6750	24" 80# I	1920	24' 0"
28-33	conc 17900	19200 conc. 4830	20" 65# I	1560	" "
21-28	conc 8950	12440 conc. 2415	15" 42# I	655	15' 6 11/16"
16-21	conc. 11600	12440 conc. 3120	15" 50# I	780	" "
17-20	conc 23200	conc 6300	20" 65# I	1110	17' 1 3/16"
20-29	conc. 21400	conc. 5790	18" 55# I	855	15'-6 11/16"
29-32	conc. 42800	conc. 11580	24" 80# I	1920	24' 0"

Assume 10' 0" of an 8" firewall on inside of court as resting 31-33, 33-16 and 16-18. Assume live load = 200# per sq ft.
Total load per sq ft. = 200# + 39# (arch) + 10# (ceiling) + 5# (floor) = 254#
12" segmental arch as floor.

Thesis M&C

TABLE 7-F



ELEVATOR BEAMS and GIRDERS.

Mark	Elevator Weight	Section	Weight	Length c. to c.
ab + dc	40000	18" 55# I	440	8' 0"
gh	"	" "	"	" "
34-33	"	24" 80# I	1600	20' 0"
e-f	"	2-20" 75# I	3600	24' 0"
33-28	"	2- " " "	"	" "
28-21	20000	15" 45# I	700	15' 6 11/16"
28-27	70000	2-20" 70# I	2800	20' 0"
21-22	30000	20"-65# I	1300	20' 0"

Total Weight of Elevator

Capacity of Cage-Size 7'0"x7'0"	4000 #
Weight of "	4000 #
" " Counterweight Frame and Weights	5656 #
3/4" Cable - 89# per ft.	10680 #
Secondary Sheave	1000 #
Machine and Controller	14500 #
Total Weight	39836 #

Typical Design of an Exterior Column

Column #3.

Concentric loads from roof beams 2-3 and 3-4 and floor beams 2-3 and 3-4.

Dead load:-

Roof = $\frac{4190+3450+630+347}{2}$ = 4334#

Floor = $\frac{19410+16050+2580+2580+690+840}{2}$ = 21075#

Total dead load = 25409#

Live load-

Roof = $\frac{4800+5810}{2}$ = — — — — — — — 5305#

Floor = $\frac{4800+5810}{2}$ = — — — — — — 5305#

Total live load = 10610#

Eccentric load from girder 3-10 and weight of stringer 2-10 and 3-9.

Dead load:-

Roof = $\frac{7640+650}{2}+\frac{495+700}{4}$ = 4420#

Floor = $\frac{11315+8400+860}{2}+\frac{520+890}{4}$ = 10980#

Total dead load = 14900#

Live load:-

Roof = $\frac{10600}{2}$ — — — — — — - = 5300#

Floor = $\frac{10600}{2}$ — — — — — — = 5300#

Total live load = 10600#

Assume a column of 2-12"-20.5# [s latticed 12' long.

(Cambria-266)

$SA = P(1+\frac{cp}{r^2})$

where P = load, A = area, S = unit stress, r = radius of gyration c = eccentricity and p = distance to outermost fibre

(Cambria-214)

r = 4.61, c = 4.12 and p = 6.81

$SA = P(1+\frac{4.12 \times 6.81}{4.61^2}) = 2.32P$

SA = 14900 x 2.32 = — — — — — — — - 34500#

SA (concentric) = — — — — — — 25400#

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Typical Design of an Exterior Column (cont.)

Dead load total (equivalent concentric) = 59,900#
SA = 10600 X 2.32 — — — — — = 24600#
SA = (concentric) — — — — = 10610#
Total equivalent concentric live load = 35210#

Revised building ordinance of Chicago specifies in art. 518(b) that 85% of live load is transferred to the columns.

35210 X .85 — — — — — = 29900#

Total load carried by column =
59900 + 29900 + 4000 (assumed weight of column and fireproofing) = 93,800#

Maximum allowed load carried = 147,000#
(Cambria - 256.)

Maximum Stress in Column due to Wind

Taking moments about center of base of building.

$$P \times 40 + P \times 40 = W \times 61.5 \qquad w = 30\#/\text{sq.ft.}$$

$$P = \frac{61.5 \times 123 \times 15.55 \times 30}{80} = 44000\#$$

But as the minimum stress on column = 271,000# (D.L. only) and as the Building Ordinance allows an increase of 50% in the unit stress if the member is designed for wind load, the stresses due to wind are negligible and will not be considered in the design of Columns.

There is also a stress in the column due to bending between the floors. The column acts as a fixed beam and the load equals 30# per sq. ft on 8'0" of wall on each side of column. Total load per ft = 480#.

$$M = \frac{wl^2}{12} = \frac{480 \times 144}{12} = 5760 \text{ ft \#s.} \qquad S = \frac{Mc}{I} = \frac{5760 \times 6.81}{256.9} = 1524\# \text{(neglect)}$$

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EXTERIOR COLUMN SCHEDULE

Story	Column	1 Conc.	1 Ecc.	2 Conc.	2 Ecc.	3 Conc.	3 Ecc.	4 Conc.	4 Ecc.	5 Conc.	5 Ecc.	6 Conc.	6 Ecc.	7 Conc.	7 Ecc.	18 Conc.	18 Ecc.	17 Conc.	17 Ecc.
Roof	Live	0	N2325 W2325	5230	4725	5300	5300	4000	4120	4000	4000	0	N2000 W2000	4000	4000	0	N2000 W2000	4000	4000
10th	Dead	0	N1870 W1865	4250	3950	4310	4430	4900	4910	3190	3360	0	N1720 W1600	3440	3050	0	N1720 W1600	3190	3570
	Live	0	N2325 W2325	4725	4725	5300	5300	4900	6460	4000	4000	0	N2000 W2000	4000	4000	0	N2000 W2000	4000	4000
9th	Dead	0	N4215 W6730	16380	7010	21090	10480	17160	6910	11500	7440	0	N6500 W5750	13010	6030	0	N6230 W5750	11500	7420

Story	Column	12-13-24-25-36-37-39-50 Conc.	12-13-24-25-36-37-39-50 Ecc.	21 Conc.	21 Ecc.	28 Conc.	28 Ecc.	51 Conc.	51 Ecc.	32 Conc.	32 Ecc.	31 Conc.	31 Ecc.	45 Conc.	45 Ecc.	56 Conc.	56 Ecc.	55 Conc.	55 Ecc.	54 Conc.	54 Ecc.	53 Conc.	53 Ecc.	52 Conc.	52 Ecc.	33 Conc.	33 Ecc.	44 Conc.	44 Ecc.
Roof	Live	4650	4650	5810	5810	8850	5810	0	N2325 W2325	3890	7700	0	N4560 W2260	4650	4650	0	N2325 W2325	4000	4000	5325	5325	5325	5325	4000	4000	25030	0	6890	4650
10th	Dead	3740	3550	4490	N10350 W25190	37840	53850	0	N1470 W1840	3100	6550	0	N3910 W1800	3940	3550	0	N1970 W1840	3110	3550	4450	4530	4450	4530	3170	3350	20680	N21900 W27910	5630	3550
	Live	4650	4650	2905	5525	0	6160	0	N2325 W2325	3890	8350	0	N4560 W2260	4650	4650	0	N2325 W2325	4000	4000	5325	5325	5325	5325	4000	4000	18020	0	6890	4650
9th	Dead	11900	7780	15420	6280	12360	5320	0	N6800 W6700	11440	12900	0	N11030 W6630	5230	3550	0	N6300 W6730	11500	4420	16570	9660	16570	6650	12510	4380	29560	0	20000	7780

Story		1	2	3	4	5	6	7	18	17	12-13-24-25-36-37-39-50	21	28	51	32	31	45	56	55	54	53	52	33	44
Roof		Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load	Total Equiv. Conc. Load
	Total Load	63590	73270	89850	77860	62200	56740	61500	55390	62600	74200	157100	238700	63270	78100	82700	62400	63270	62250	84100	77100	56230	226760	82000
	Percent L.L. 85	19,800	27,200	29900	28900	22500	17000	22500	17000	22600	26200	31000	34100	19800	38300	29700	26200	19800	22600	30100	30100	22600	36800	30100
	Total L.L.	23,300	32000	35200	33450	26560	20060	26560	20060	26600	30900	36460	40150	23300	45090	35000	30900	23300	26600	35400	35400	26600	43050	35400
10th	L.L. Increment	23,300	32000	35200	33450	26560	20060	26560	20060	26600	30700	36460	40150	23300	45090	35000	30900	23300	26600	35400	35400	26600	43050	35400
	Total D.L.	36290	46070	59950	44460	39700	39190	39000	38590	39700	48140	126160	204600	43470	57800	60100	36200	43470	37630	54000	47000	33630	89960	51900
	D.L. Increment	36290	46070	59950	44460	39700	39190	39000	38590	39700	48140	126160	204600	43470	57800	60000	36200	43470	39630	54000	47000	33630	89960	51900
9th	Section	2-12"-20.5# [s Latticed									2-12"-20.5# [s Latticed	2-12"-25# [s Latticed	2-12"-35# [s Latticed	2-12"-20.5# [s Latticed								2-12"-20.5# [s Latticed	2-15"-33# [s Latticed	2-12"-20.5# [s Latticed
	Total Load	125130	165270	212030	127780	143300	141290	141600	138670	143300	173140	231900	300420	157670	222780	228800	130500	157670	143230	191000	170500	129630	308480	187700
	Total D.L.	90160	115970	156930	129980	101700	109190	100000	106590	101700	124940	183000	251320	120470	157470	162800	84200	120470	101630	137800	115000	79030	249080	152700
	Percent L.L. 75	35000	49600	55100	57800	41600	32100	41600	32100	41600	38300	48900	49100	37200	72300	56000	46300	37200	41600	53200	55500	40000	57400	55000
8th	Total L.L.	46,600	66200	73600	77050	55560	42860	55560	42860	55600	48400	65100	65550	47700	96670	74800	61800	47700	55600	71000	74000	53200	79100	73400
	L.L. Increment	23300	34200	38400	43600	29000	22800	29000	22800	29000	33600	28600	25400	20400	51600	39800	30900	26400	29000	38600	38600	26600	36040	38000
	D.L. Increment	53940	64700	96980	70520	62000	70005	61000	68200	62000	78600	56840	46720	77000	90480	102800	48000	77000	62000	83800	68000	45400	59120	80800
7th	Section	2-12"-20.5# [s Latticed	2-12"-35# [s Latticed								2-12"-35# [s Latticed	2-12"-25# [s 2-[illegible]	2-12"-25# [s 2-3/8" [illegible] Pl	2-12"-25# [s Latticed		2-12"-35# [s Latticed	2-12"-20.5# [s Latticed	2-12"-35# [s Latticed			2-12"-[illegible] Latticed	2-12"-20.5# [s Latticed	2-15"-45# [s Latticed	2-12"-35# [s Latticed
	Total Load	176330	239770	314030	257300	207800	203300	206100	200190	207800	253640	301340	357720	227470	311860	315400	294960	227470	207830	278300	244300	178850	383200	274800
	Percent L.L. 65	47000	62100	70500	74000	52100	59500	52100	59500	52100	60500	61100	59300	46000	70700	69000	61400	46000	52200	67500	69500	52800	75000	69500
	Total L.L.	72200	95650	108600	113850	80280	60920	80280	60920	80320	93200	94100	91350	70700	89560	106200	94500	70700	80520	104000	107000	81400	115140	106600
6th	L.L. Increment	25600	29450	35000	36800	24720	18060	24720	18060	24720	28700	29000	25800	21000	42800	31400	32700	21000	24720	33000	33000	28200	36040	33200
	Total D.L.	149330	177870	243530	183300	155700	164800	154000	160690	155700	193140	240240	298420	181470	227160	244400	135560	181470	155630	210800	175800	126050	308200	205300
	D.L. Increment	59200	62200	86600	63320	54000	55600	54000	54100	54000	68400	57240	47180	61000	76880	81600	49360	61000	54000	73000	60800	47020	59120	72600
5th	Section	2-12"-30# [s Latticed	2-12"-20.5# [s 2-16"x1/2" Pls								2-12"-20.5# [s 2-16"x1/2" Pls	2-12"-30# [s 2-16"x7/16" Pls	2-12"-30# [s 2-16"x7/16" Pls	2-12"-20.5# [s 2-16"x1/2" Pls		2-12"-20.5# [s 2-16"x1/2" Pls	2-12"-30# [s Latticed	2-12"-20.5# [s 2-16"x1/2" Pls			2-12"-20.5# [s 2-16"x1/2" Pls	2-12"-30# [s Latticed	2-15"-55# [s Latticed	2-12"-20.5# [s 2-16"x1/2" Pls
	Total Load	248330	309230	408100	329900	268300	264600	265700	258690	268100	329440	365700	410240	293570	404840	402800	247600	293570	268100	360440	314240	227550	450520	355300
	Percent L.L. 55	57000	69000	78000	83000	58000	43600	57500	43500	58000	67500	68000	64500	50500	100000	76000	67800	50500	58000	75500	77100	58200	83200	77000
	Total L.L.	93000	125100	144700	151050	105240	79220	104840	79220	105280	122200	123300	117550	91900	182680	138000	123120	91900	105280	137260	140260	106040	151200	140100
4th	L.L. Increment	20800	29460	33100	37200	24960	18300	24960	18300	24960	29000	29200	26200	21200	43180	31800	28620	21200	24960	33260	33260	24640	36040	33500
	Total D.L.	197330	240230	330100	246900	210300	221000	208200	215190	210100	261940	297700	345740	243070	304840	326800	179800	243070	210100	284940	237140	169350	367320	278300
	D.L. Increment	48000	62360	86600	65600	54600	56200	54200	54400	54400	68800	57440	47320	61600	77680	82400	46240	61600	54400	74140	61340	43300	59120	73000
3rd	Section	2-12"-25# [s 2-16"x1/4" Pls	2-12"-25# [s 2-16"x5/8" Pls								2-12"-25# [s 2-16"x5/8" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-25# [s 2-16"x5/8" Pls		2-12"-25# [s 2-16"x5/8" Pls	2-12"-25# [s 2-16"x1/4" Pls	2-12"-25# [s 2-16"x5/8" Pls			2-12"-25# [s 2-16"x5/8" Pls	2-12"-25# [s 2-16"x3/8" Pls	2-15"-35# [s 2-20"x7/16" Pls	2-12"-35# [s 2-16"x5/8" Pl
	Total Load	301980	374960	505850	404550	330000	325960	327200	305885	329090	407690	424530	463900	361220	488545	486815	301870	361220	329620	446170	385240	277890	532240	439440
	Percent L.L. 50	56850	77275	87750	94125	65100	48760	64900	48215	66290	75950	75960	72355	56550	112855	85115	75860	56550	65120	85600	86760	65320	91160	87140
2nd	Total L.L.	113700	154550	175500	188250	130200	97580	129800	96430	132585	151900	151960	144710	113100	225710	170230	151720	113100	130240	171200	173520	130640	192320	174280
	L.L. Increment	20700	29450	33800	37200	24960	18300	24960	17210	27300	29700	28660	27160	21200	43030	32230	28600	21200	24960	34000	33260	24600	41120	34180
	Total D.L.	245130	302690	418100	310420	264900	277200	262300	25670	262800	331740	348550	391550	304670	375690	401700	226000	304670	264500	360540	298480	212570	441080	352300
	D.L. Increment	47800	62460	88000	63520	54600	56200	54200	42480	52700	69800	50850	45810	61700	70850	74900	46200	61600	54400	75600	61340	43220	73760	54000
1st	Section	2-12"-25# [s 2-16"x3/4" Pls	2-12"-30# [s 2-16"x9/16" Pl	2-12"-35# [s 2-16"x3/4" Pl	2-12"-30# [s 2-16"x9/16" Pls					2-12"-30# [s 2-16"x9/16" Pls	2-12"-35# [s 2-16"x3/4" Pl	2-12"-35# [s 2-16"x5/8" Pls	2-12"-35# [s 2-16"x5/8" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-35# [s 2-16"x3/4" Pls	2-12"-35# [s 2-16"x3/4" Pls	2-12"-25# [s 2-16"x3/8" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-35# [s 2-16"x3/4" Pls	2-12"-30# [s 2-16"x9/16" Pls	2-12"-25# [s 2-16"x3/8" Pls	2-15"-35# [s 2-20"x5/8" Pls	2-12"-35# [s 2-16"x3/4" Pls
	Total Load	331430	418800	558450	445860	363680	357980	360780	346770	372985	450140	462055	506440	397780	552445	549600	332200	397770	363300	472490	424425	305730	573420	485085
	Percent L.L.	62100	84700	96250	103475	71380	53380	71180	57440	81445	83400	88855	89625	61900	139355	103025	83060	61900	71400	94150	95125	71500	111940	95685
	Total L.L.	124200	169400	192500	206950	142760	106760	142360	114885	162890	166800	176710	173250	123800	278710	206050	166120	123800	142800	188300	190250	143000	223880	191370
	L.L. Increment	10500	14825	17000	18700	12560	9240	12560	18450	30300	14900	24750	28540	10700	53000	35820	14400	10700	12560	17025	16725	12360	31560	17090
	Total D.L.	269330	334100	462200	342380	292300	305600	289600	289330	291540	366740	373700	419820	335870	413090	446580	249140	335870	291900	398340	329300	234230	481480	389400
	D.L. Increment	24200	31400	44100	31960	27400	28400	27300	31660	28740	35000	25150	28270	31200	37400	44880	23140	31200	27400	37800	30800	21660	40400	37100
Basement	Section	2-12" 30# [s, 3/4" Pl	2-35# [s, 2-9/16" Pl	2-40# [s, 2-9/16" Pl	2-35# [s, 9/16" Pl					2-35# [s, 9/16" Pl	2-40# [s, 9/16" Pl	2-40# [s, 5/8" Pl	2-40# [s, 5/8" Pls	2-35# [s, 9/16" Pls	2-40# [s, 3/4" Pl	2-40# [s, 7/16" Pl	2-30# [s, 3/4" Pl	2-35# [s, [illegible]	2-35# [s, 9/16" Pls	2-40# [s, [illegible]	2-35# [s, 9/16" Pls	2-30# [s, 5/8" Pl	2-15"-35# [s, 3/4" Pl	2-40# [s, 5/8" Pl

THESIS

DESIGN OF THE STEEL SKELETON FOR AN OFFICE BUILDING

COLUMN SCHEDULE — TABLE Ic

MAY 1912 — F. J. Mack – C. W. Collins

Typical Design of an Interior Column

Column # 14

Contributing loads from girders 14-23 and 11-14 and beams 13-14 and 14-15 and ½ of dead load load from stringers 12-14, 13-23, 14-22, and 11-15

Live load:-

Roof = $\frac{9450+9450+9300+9600}{2}$ = 18925#

Floor = $\frac{9450+9450+9300+9600}{2}$ = 18925#

Dead load- Total live load = 37850#

Roof = $\frac{6800+6800+6700+6900}{2}$ + 650 + 650 + 400 + 495 +

$\frac{400+400+495+495}{4}$ = 15145#

Floor = $\frac{10950+8100+10950+8100+860+860+15000+15800+680+660}{2}$

+ $\frac{560+560+495+495}{4}$ = 36453#

Total Dead Load = 36453 + 15145 = 51600#

" load = 51600# + 15145 + 4000 (assumed weight of a 24' column) = 70745#

Use a column of 2-12"-20.5# [s latticed; load allowed = 14,700# for 12'0" column, because a 12" column used thru all the floors and also to make proper beam connections (Cambria-256-load)

E VII

ed

aissons

Chicago

ht of

$\frac{3}{4}$"

37)

INTERIOR COLUMN SCHEDULE

STORY	COLUMN	16	11-14-23 26-35	38	40	49	48	41	34	27	22	15	10	9	8	47	42	43	46
Roof	Dead Load	10770	15150	13660	17920	13000	17580	25980	26700 40100	21900 73500	17100 31200	16930	17130	15840	9700	17600	22710	16000	12800
10th	Live Load	15620	18890	18080	16310	16000	21300	26630	32130	26760	21200	21200	21200	19600	16000	21300	26640	19700	16000
	Dead Load	32240	19350	34500	28870	23750	31200	46700	47500	37200	31600	34650	30250	22600	26350	31760	39350	33300	22600
9th	Live Load	15950	18900	17450	16100	16000	21300	26370	30150	23600	19250	21250	19250	19000	16000	21300	25900	20350	16000
	Total D.L.	45020	34500	48160	41790	36750	48780	72680	114300	132600	79900	51580	47380	38440	36250	49360	62060	49300	35400
	Total L.L.	31570	37790	36130	32410	32000	42600	53000	62300	50400	40450	42450	40450	38600	32000	42600	52540	40050	32000
10th	Percent L.L. 85	26800	32200	30700	27600	27200	36200	45000	53000	42800	34400	36000	34400	32800	27200	36200	44500	34000	27200
	Total Load	71820	66700	78860	69390	63950	84980	117680	167300	175400	114300	87580	81780	71240	63450	85560	106560	83300	62200
9th	Section	2-12"-20.5#[s Latticed					2-12"-20.5#[s Latticed	2-15"-33#[s Latticed		2-15"-33#[s Latticed	2-12"-20.5#[s Latticed					2-12"-20.5#[s Latticed	2-15"-33#[s Latticed	2-12"-20.5#[s Latticed	2-12"-20.5#[s Latticed
	Total D.L.	109500	73200	117160	99530	84250	111180	166080	209300	207000	143100	120880	107880	83640	88950	112880	140760	115900	80600
	Total L.L.	63490	75590	71030	64610	64000	85200	105740	122600	93600	78950	84950	78950	76600	64000	85200	104340	80750	64000
8th	Percent L.L. 75	47500	56700	53300	48500	48000	64000	79300	92000	73300	59100	63700	59100	57500	48000	64000	78400	60500	48000
	Total Load	157000	129900	170460	148030	132250	175180	245380	302300	280300	202200	184580	166980	141140	136950	176880	219070	176400	128600
7th	Section	2-12"-25#[s Latticed	2-12"-20.5#[s Latticed	2-12"-30#[s Latticed	2-12"-25#[s Latticed	2-12"-20.5#[s Latticed	2-12"-30#[s Latticed	2-15"-45#[s Latticed		2-15"-45#[s Latticed	2-12"-30#[s Latticed	2-12"-30#[s Latticed	2-12"-25#[s Latticed	2-12"-20.5#[s Latticed	2-12"-20.5#[s Latticed	2-12"-30#[s Latticed	2-15"-33#[s Latticed	2-12"-30#[s Latticed	2-12"-20.5#[s Latticed
	Total D.L.	173980	111900	186160	157270	131750	173580	254480	304300	281400	206300	190180	168380	128840	141650	176400	219460	182500	125800
	Total L.L.	95300	113390	105930	96810	96000	127800	158480	182900	144800	117450	127450	117450	114600	96000	127800	156140	121450	96000
6th	Percent L.L. 65	62000	73600	68800	63000	62500	83000	103000	118800	94000	76400	83000	76400	74500	62500	83000	101500	79000	62500
	Total Load	235980	185500	254960	220270	194250	256580	362480	423100	375400	282700	273180	244780	203340	204150	259400	320960	261500	188300
5th	Section	2-12"-35#[s Latticed	2-12"-30#[s Latticed	2-12"-40#[s Latticed	2-12"-35#[s Latticed	2-12"-30#[s Latticed	2-12"-40#[s Latticed	2-15"-35#[s 2-20"×3/8" Pls.		2-15"-35#[s 2-20"×3/8" Pls.	2-12"-20.5#[s 2-16"×3/8" Pls.	2-12"-20.5#[s 2-16"×3/8" Pls.	2-12"-40#[s Latticed	2-12"-35#[s Latticed	2-12"-35#[s Latticed	2-12"-40#[s Latticed	2-15"-50#[s Latticed	2-12"-40#[s Latticed	2-12"-30#[s Latticed
	Total D.L.	238400	150600	255160	215000	179250	235980	352880	399300	355800	269500	159480	228880	174040	194350	239920	298160	249100	171000
	Total L.L.	127200	151190	140830	129010	128000	170400	211220	243200	192000	155950	169950	155950	152600	128000	170400	207940	162150	128000
4th	Percent L.L. 55	70000	83100	77400	71000	70400	93800	116000	134000	106000	85600	93500	85600	84000	70400	93800	114000	89200	70400
	Total Load	308460	233700	332560	286010	249650	329780	468880	533300	461800	355100	352980	314450	258040	264750	333720	412160	338300	241400
3rd	Section	2-12"-25#[s 2-16"×3/8" Pls.	2-12"-20.5#[s 2-16"×5/16" Pls.	2-12"-30#[s 2-16"×3/8" Pl.	2-12"-25#[s 2-16"×5/16" Pls.	2-12"-20.5#[s 2-16"×5/16" Pls.	2-12"-30#[s 2-16"×3/8" Pls.	2-15"-33#[s 2-20"×5/16" Pls.		2-15"-33#[s 2-20"×5/16" Pls.	2-12"-35#[s 2-16"×5/16" Pls.	2-12"-35#[s 2-16"×5/16" Pls.	2-12"-30#[s 2-16"×3/8" Pls.	2-12"-25#[s 2-16"×3/8" Pls.	2-12"-25#[s 2-16"×3/8" Pls.	2-12"-30#[s 2-16"×3/8" Pls.	2-15"-33#[s 2-20"×3/8" Pls.	2-12"-30#[s 2-16"×3/8" Pls.	2-12"-20.5#[s 2-16"×5/16" Pls.
	Total D.L.	281160	187300	324160	272750	226750	298380	446280	494100	429200	332700	328780	289380	219240	247050	303440	376860	315700	216200
	Total L.L.	160440	188790	175730	161210	160000	213000	263960	303500	239100	194450	212450	194450	190600	160000	213000	259740	202850	160000
2nd	Percent L.L. 50	80220	94500	87870	80600	80000	106500	131980	151750	119600	97230	106230	97230	95300	80000	106500	129870	101430	80000
	Total Load	361380	283800	412030	353350	306750	404880	578360	646050	549800	429930	435010	386610	314540	327050	409940	506730	417130	296200
1st	Section	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-25#[s 2-16"×3/8" Pls.	2-12"-35#[s 2-16"×1/2" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-35#[s 2-16"×3/8" Pls.	2-12"-35#[s 2-16"×1/2" Pls.	2-15"-45#[s 2-20"×5/16" Pls.	2-15"-50#[s 2-20"×3/8" Pls.	2-15"-40#[s 2-20"×3/16" Pls.	2-12"-40#[s 2-16"×7/16" Pls.	2-12"-40#[s 2-16"×7/16" Pls.	2-12"-35#[s 2-16"×1/2" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-35#[s 2-16"×1/2" Pls.	2-15"-35#[s 2-20"×9/16" Pls.	2-12"-35#[s 2-16"×7/16" Pls.	2-12"-25#[s 2-16"×3/8" Pls.
	Total D.L.	310030	208650	358660	301620	250500	329580	492980	541800	467400	364300	363430	319630	241840	273400	335200	416210	319000	238800
	L.L.	194630	207890	193180	177310	176000	234300	290330	333650	262800	213700	233700	213700	209600	176000	234300	285640	223200	176000
	Percent L.L.	97315	103950	96590	88660	88000	117150	145170	166830	131400	106850	116850	106850	104800	88000	117150	142820	111600	88000
	Total Load	407345	312600	455250	390280	338500	446730	638150	708630	598800	471150	480280	426480	346640	361400	452350	559030	460600	321800
Basement	Section	2-12"-40#[s 2-16"×3/8" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-40#[s 2-16"×1/2" Pls.	2-12"-40#[s 2-16"×3/4" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-40#[s 2-16"×1/2" Pls.	2-15"-40#[s 2-20"×3/4" Pls.	2-15"-50#[s 2-20"×3/4" Pls.	2-15"-40#[s 2-20"×3/4" Pls.	2-12"-40#[s 2-16"×7/16" Pls.	2-12"-40#[s 2-16"×7/16" Pls.	2-12"-40#[s 2-16"×1/2" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-40#[s 2-16"×1/4" Pls.	2-12"-40#[s 2-16"×1/2" Pls.	2-15"-55#[s 2-20"×3/4" Pls.	2-12"-40#[s 2-16"×1/2" Pls.	2-12"-40#[s 2-16"×1/4" Pls.

COURT COLUMNS

29	20	30	19	COLUMN	
2528 Ecc. 10300 Conc. Res. 16175	2528 Ecc. 7615 Conc. 13480 Res.	6160	4860	Dead Load	
3350 Ecc. 6180 Conc. 13960 Res.	3350 Ecc. 4616 Conc. 10700 Res.	1160	1160	Live Load	
30140	24180	7320	6020	Total Load	
17130	13890	3619 Ecc. 18820 Conc. 21170 Res.	3686 Ecc. 13330 Conc. 22210 Res.	D.L. Increment	Basement
35310	27570	33290	26780	Total D.L.	
53500	43700	12490 Ecc. 18675 Conc. 47580 Res.	12450 Ecc. 12030 Conc. 40930 Res.	L.L. Increment	
67460	54400	48140	42090	Total L.L.	
57400	46100	41400	35800	Percent L.L. 85	
[illegible]	73470	74690	62580	Total Load	
2-12"-20.5#[s Latticed				Section	

THESIS

DESIGN OF THE STEEL SKELETON FOR AN OFFICE BUILDING

COLUMN SCHEDULE

TABLE 2c

MAY 1912

F. J. Mack - C. W. Collins

Typical Design of a Column Base

Column #28

Allowed bearing on a 1-$2\frac{1}{2}$-5 machine mixed Portland cement concrete, which is used in caissons is 350# per sq. in. (City Building ordinance of Chicago - 533).

Total load - 506,440# + 22,000 # (assumed weight of columns and fireproofing) = 528,440#.

$$\frac{528,440}{350} = 1521 \text{ sq. in.}$$

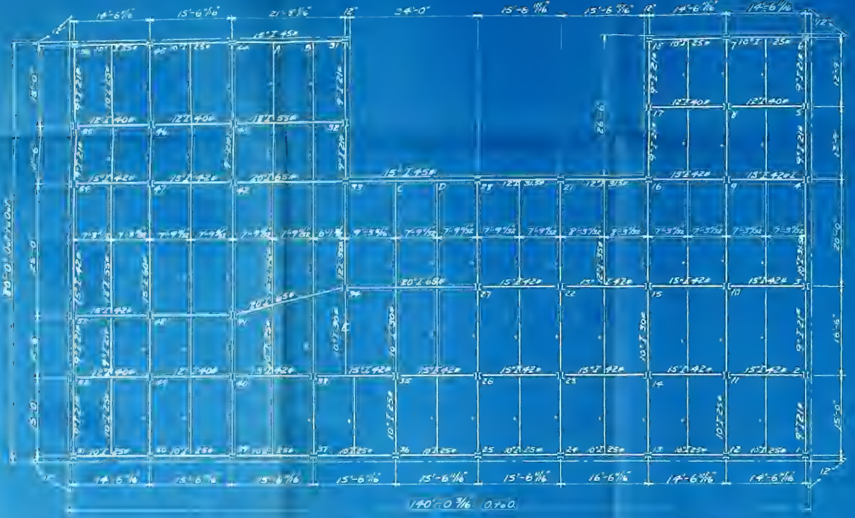
For a load of 528,440# a thickness of $1\frac{3}{4}$" is required. (American Bridge Co. St'ds. - 137)

COLUMN BASES.

Column Number	Total Load	Required Area	Size of Plate
1	353430	1010 □"	30"X30"X1½"
11-14-etc.	334600	955 □"	" " "
2	440800	1260 □"	" " "
5	385680	1100 □"	" " "
6	380980	1090 □"	" " "
7	382780	1090 □"	" " "
18	368770	1025 □"	" " "
17	394985	1130 □"	" " "
51	419780	1200 □"	" " "
45	354200	1010 □"	" " "
56	419770	1200 □"	" " "
55	385300	1100 □"	" " "
53	446425	1275 □"	" " "
52	327730	950 □"	" " "
16	429345	1225 □"	" " "
40	412280	1175 □"	" " "
49	361500	1030 □"	" " "
10	448480	1280 □"	" " "
9	368640	1050 □"	" " "
8	383400	1090 □"	" " "
46	343800	980 □"	" " "
4	467800	1335 □"	33"X33"X1¾"
12-13-etc.	472170	1345 □"	" " "
21	484055	1380 □"	" " "
28	528440	1510 □"	" " "
54	514490	1475 □"	" " "
44	507050	1450 □"	" " "
38	477250	1365 □"	" " "

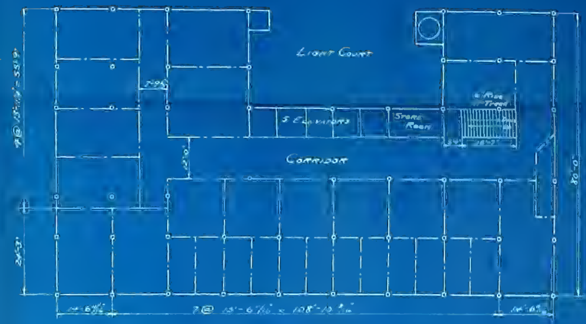
COLUMN BASES (cont.)

Column Number	Total Load	Required Area	Size of Plate
48	468730	1340 □"	33"X33"X1¾"
22	493150	1410 □"	" " "
47	474350	1350 □"	" " "
15	502280	1435 □"	" " "
43	482600	1380 □"	" " "
3	580450	1610 □"	40"X40"X2"
32	574445	1608 □"	" " "
31	571600	1605 □"	" " "
33	620920	1770 □"	" " "
41	665650	1900 □"	" " "
34	736130	2100 □"	" " "
27	626300	1790 □"	" " "
42	581030	1660 □"	" " "



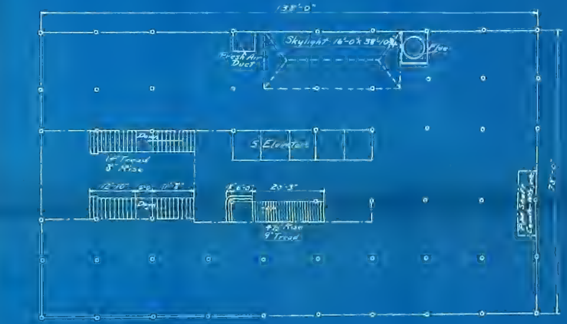
Roof Framing Plan

Scale 1" = 10'-0"

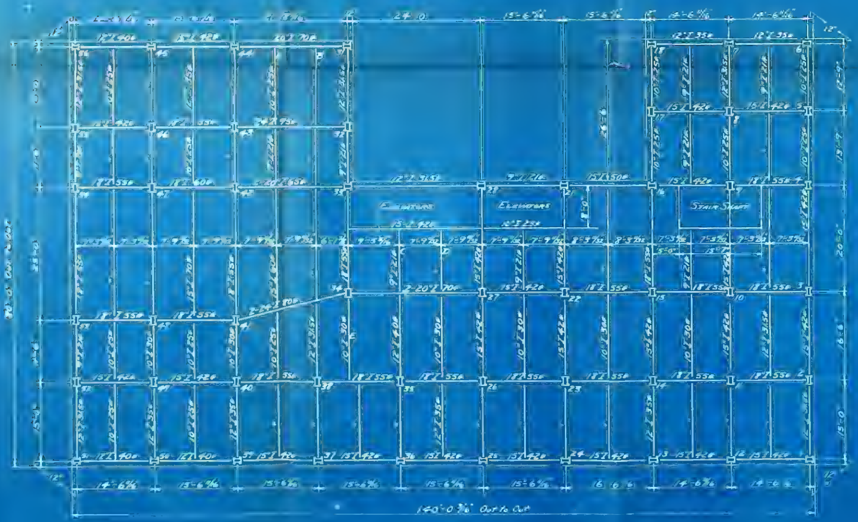


Typical Plan of Partitions on Office Floors

Scale 1" = 15'-0"

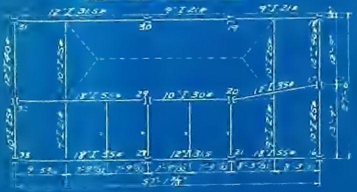


Plan of Banking (2nd) Floor

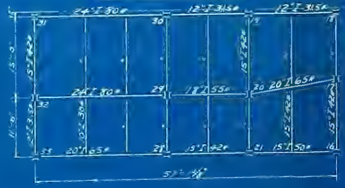


Typical Floor Framing Plan

Court Roof Framing Plan



Court Floor Framing Plan



THESIS

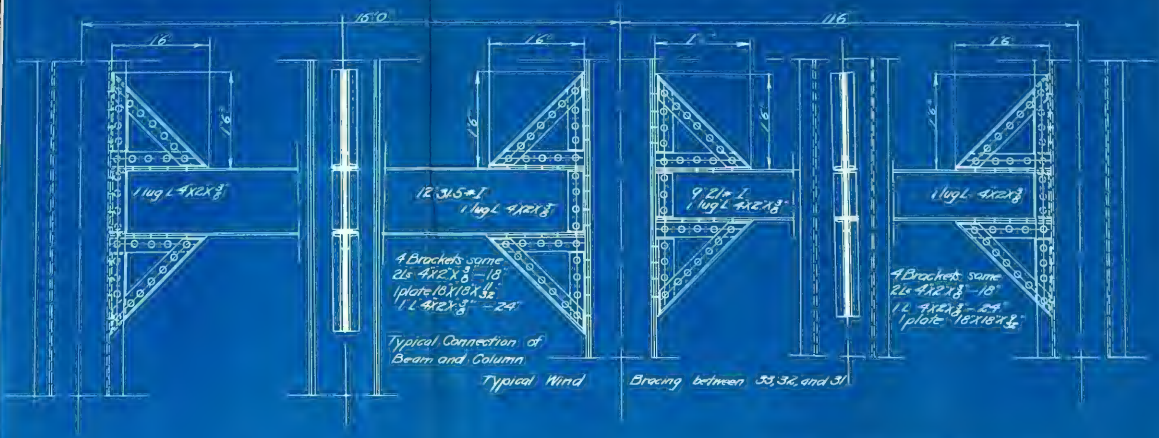
Design of the Steel Skeleton for an Office Building

Framing Plans

Plate VIII

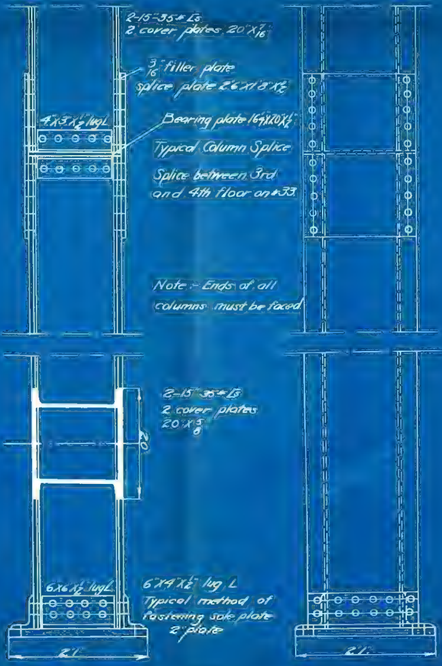
May 1912

Frank J. Mack — C. W. Collins


15'0"
11'6"
1'6"
1'6"
1'-"
1'6"
1'6"
1'6"
1'6"
1'6"
1 lug L 4"X2"X$\frac{3}{8}$"
12" 31.5# I
1 lug L 4"X2"X$\frac{3}{8}$"
4 Brackets same
2Ls 4"X2"X$\frac{3}{8}$" -18"
1 plate 18"X18"X$\frac{11}{32}$"
1 L 4"X2"X$\frac{3}{8}$" -24"
9" 21# I
1 lug L 4"X2"X$\frac{3}{8}$"
1 lug L 4"X2"X$\frac{3}{8}$"
4 Brackets same
2Ls 4"X2"X$\frac{3}{8}$" -18"
1 L 4"X2"X$\frac{3}{8}$" -24"
1 plate 18"X18"X$\frac{3}{8}$"

Typical Connection of Beam and Column

Typical Wind Bracing between 33, 32, and 31

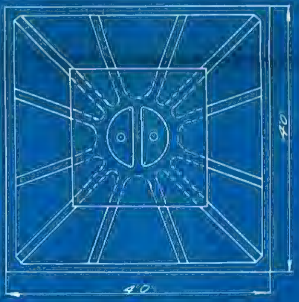

2-15"-35# Ls
2 cover plates 20"X$\frac{7}{16}$"
$\frac{3}{16}$" filler plate
splice plate 2'6"X1'8"X$\frac{1}{2}$"
4"X3"X$\frac{1}{2}$" lug L
Bearing plate 16$\frac{1}{4}$"X20"X$\frac{1}{2}$"
2-15" 35# Ls
2 cover plates
20"X$\frac{5}{8}$"
20"
6"X6"X$\frac{1}{2}$" lug L
6"X4"X$\frac{1}{2}$" lug L
2" plate
21"
21"

Typical Column Splice

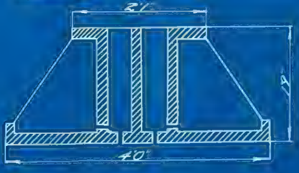
Splice between 3rd and 4th floor on #33

Note:- Ends of all columns must be faced

Typical method of fastening sole plate



American Bridge Company Standard 4'0"X4'0" Cast Iron Column Base - No. 48c. for Column #33



THESIS.

DESIGN OF THE STEEL SKELETON FOR AN OFFICE BUILDING

TYPICAL DETAILS

MAY, 1912

PLATE IX

C. W. Collins Frank J. Mack